Abstract: The major problem facing the growth of nuclear power in the U.S. is the waste produced. The goal of our project is to create an educational presentation for lawmakers regarding nuclear waste. The current US policy is to use permanent geologic repositories for storage of high level waste, waste that will be dangerous for many thousands of years, and use temporary underground burial for low level wastes, which normally decay in under a century. We recommend reprocessing the waste, where spent fuel is recycled and cleaned for reuse in reactors, and investing in developments in waste disposal technology such as LASER ablation. We also created a website which can train people across the country to give our presentation to others.

Nuclear Waste: Policies and Prospects

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Great Problems Seminar: Power the World

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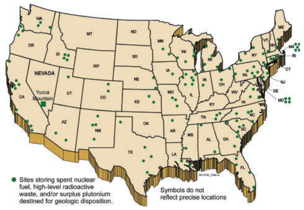
Methodology:

The original concept for our project was for us to create some kind of educational material which we could give to lawmakers to inform them which policies should be changed regarding nuclear power, based on research that we completed. We eventually narrowed our preliminary research down to what should be done with the spent nuclear fuel from civilian reactors in the United States. We broke this topic down into several different topics which we felt were important. Those topics were: The U.S.' current policies and implementations, alternatives that are being used globally, and future developments and current research in the area of waste disposal. After finishing our research, we wrote up our findings, and based our presentation on the recommendations and proposals that we made. In order to present our material to the largest possible audience, we also decided to create a website where people could get not only the presentation, but also all of the relevant material to be able to give the presentation.



Current United States Policies:

The Nuclear Waste Policy Act of 1982 sets the grounds for the disposal of high-level nuclear waste (HLW) in America. It states that waste is to be disposed of in deep underground storage facilities, or geologic repositories. Under the NWPA, the only current candidate for such a site is the Yucca Mountain facility in Nevada. The NWPA also gives three Federal agencies responsibility for HLW: the DOE, the EPA, and the NRC. The DOE is responsible HLW storage facilities while EPA is in charge of developing site-specific environmental standards for each facility, and the NRC is charged with setting regulations for implementing the safety standards set by EPA, and for licensing and overseeing the construction of a repository and its operation.

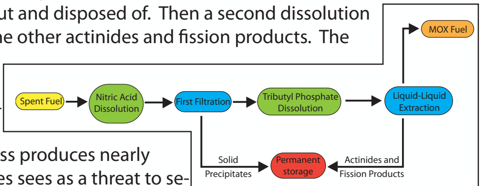
Yucca Mountain ridge crest

Dry Storage Casks

Before being buried, HLW is stored in open pools allowing for much of the excess heat dissipate before being placed in dry-casks for underground storage. Low-level radioactive waste is also buried, but its disposal doesn't call for deep underground burial. Instead it can be buried 30 feet below ground level. The burial takes place in commercially operated facilities that are licensed by the NRC and since LLW decays at a much higher rate than HLW, material can be removed so the space can be re-used.

Alternatives:

Fuel reprocessing is the primary alternative to permanent storage. Through a variety of chemical reactions and physical separations, useful isotopes can be isolated and mixed back into reactors as MOX (Mixed Oxide fuel). The current standard, PUREX (Plutonium-Uranium Extraction) is a simpler process, and can reduce the amount of waste needing storage in HLW facilities by almost 50%. To do this the spent fuels are first dissolved in a strong acid, and then any particulates are filtered out and disposed of. Then a second dissolution happens is an organic solvent to separate the Pu and U from the other actinides and fission products. The liquid is then separated into two solutions, one containing Pu and the other U. France has been using this method to process its waste for many years, and the process has proven commercially viable. However, it violates U.S. policies regarding nuclear proliferation. The PUREX process produces nearly pure plutonium, which the United States sees as a threat to security. Because of this, the U.S. is looking into the UREX processes, which have an even greater return. This gain comes from not using just the UREX methods, but combining them with other separations to minimize the waste which needs permanent storage. The UREX+ processes also eliminate the threat of nuclear weapons development since uranium and plutonium remain mixed throughout the process.



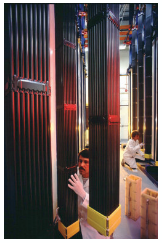
The PUREX Cycle

La Hague Reprocessing Plant, France

Future Prospects:

The solutions we have now are temporary, and typically do not address the issue that the nuclear waste will remain hazardous for many thousands of years. Research is being done on several methods to reduce the half life of certain isotopes. At the University of Strathclyde, researches have successfully transmuted iodine-129 into iodine-128 through a laser ablation process. This reduces the half life of the dangerous material from almost 16 million years to only 25 minutes. Once perfected, this solution may also be applied to other dangerous isotopes of uranium and other actinides. Research is also ongoing in metal sulfide absorption and isolation. If metal sulfides could be used to remove some of the more difficult fission products, even less waste would have to be stored, and the lifespan of facilities could be greatly extended. The ongoing use of fast breeder reactors is not a new facet of nuclear waste disposal, but some new experiments show that spent fuel can be put into high-temperature breeder reactors to condense the waste even further.

Iodine crystals



Nuclear fuel being inspected in the U.S.

Presentation:

- Educate lawmakers about nuclear waste policy
  - What is being done
  - Make recommendations on what should be done
    - Specifically, use reprocessing and invest in new research on waste disposal
- Inform legislatures of new developments in disposal technology
  - Recommend where to invest in research
- Gave the presentation to our peers
  - Took the feedback and improved the presentation
  - Improved our teaching materials

Education:

The media that we decided to use for educating potential presenters was the web. Since it is available to anyone, everyone can go in and find out what we have researched and learn the same material as we have. It is an interactive learning experience which teaches the user everything they need to know to be able to give the same presentation, and even to answer additional questions that may be asked. As with our research, the material is broken down into sections pertaining to the U.S. policies toward nuclear waste, alternatives to those polices, and developments that are being made in disposal technologies. Links to our resources are available, as well as links to the appropriate government agencies where people can learn more about nuclear waste.

U.S.NRC

Final Thoughts and Resources:

We make several recommendations to law makers in regards to nuclear waste disposal. First, reprocessing of nuclear waste should be considered as a viable way of extending the life of permanent storage facilities. This would allow the U.S. to develop better ways of permanently disposing of the waste, whether it is through advanced decomposition, or through another method. We also recommend that more permanent storage sites be looked at, now that the Yucca Mountain facility is in the final stages of approval.

For a complete list of sources, please visit http://users.wpi.edu/~rcrock/PTW